REMARKS/ARGUMENTS

These remarks are made in response to the Office Action of May 26, 2005 (Office Action). This response is filed after the 3-month shortened statutory period, and as such, a retroactive extension of time is hereby requested. The Examiner is authorized to charge the appropriate extension fee to Deposit Account 50-0951.

In paragraph 2 of the Office Action, Claims 1-51 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,719,997 to Brown, *et al.* (hereinafter Brown) in view of U.S. Patent No. 6,292,779 to Wilson, *et al.* (hereinafter Wilson).

Independent Claims 1, 16, 18, 20, 24, 39, 43, and 48 have each been amended to further emphasize certain aspects of Applicants invention. Dependent claims, 23, 32, and 42 have also been amended to emphasize certain aspects of the invention. These amendments are supported throughout the Specification, as described herein. No new matter is introduced by virtue of the amendments.

I. Applicant's Invention

It may be useful to reiterate certain aspects of Applicants' invention prior to addressing the cited references. The invention is directed to methods and systems that include grammars within a statistical parser for use with a natural language understanding (NLU) system. (See, e.g., Specification, p. 14, lines 1-4.)

One embodiment of a method for including grammars in a statistical parser in an NLU system, according to the invention, includes receiving a text input and applying a first context free grammar (CFG) to the text input to determine substrings and corresponding parse trees. The substrings and corresponding parse trees further correspond to the first CFG. The method further includes examining each possible substring using an inventory of ordered, grammar-related queries that correspond to the

CFG. Each of the queries, according to the method, are ordered during training of the NLU system to form a decision tree. (See, e.g., Specification, p. 16, lines 2-3.)

The ordering of the queries, moreover, is a statistical ordering based either on a minimization of conditional entropy or maximization of a likelihood that a resulting model predicts data used to train the NLU system. (See, e.g., Specification, p. 16, lines 7-15.) The result is that grammars are included in the statistical parser. (Specification, p. 16, lines 4-5.) This can significantly reduce the amount of training data and time necessary to properly train the NLU system. (Specification, p. 16, lines 4-5.) Moreover, the grammar can later be changed without requiring that the system be retrained. (Specification, p. 16, lines 5-6.)

Another method for including grammars in a statistical parser in an NLU system, according to the invention, also includes receiving a text input and applying a first context free grammar (CFG) to the text input to determine substrings and corresponding parse trees wherein the substrings and corresponding parse trees further correspond to the CFG. According to this embodiment, though, the method includes examining each possible substring using one or more weighted, grammar-related features corresponding to the CFG. (See, e.g., Specification, p. 17, lines 3-11.) Each feature, more particularly, is weighted during training of the NLU system, each weight being determined based on a maximum entropy model. This yields a maximum entropy parser. (Specification, p. 17, line 11.)

II. <u>The Claims Define Over The Prior Art</u>

As already noted, each of the claims was deemed to be rendered obvious by Brown in view of Wilson. Brown is directed to a method of recognizing speech input by selectively creating and maintaining grammar representations in real-time. (Col. 3, lines 23-24; Abstract.) Brown "evolves" an instantiation of a grammar by selectively creating

and destroying portions of the grammar instantiation based on "ephemeral models." (Co. 3, lines 24- 28.) A grammar representation is created for each frame of received speech and, for each representation, a probability score is derived indicating the likely accuracy of a particular representation. Grammar representations having probability scores above a predetermined threshold are maintained while those below the threshold are not. (Col. 5, lines 15-54.) Accordingly, as more speech frames are received, additional grammar representations are created and probability scores are updated. When an entire speech input has been received, the chain of grammar representations having the highest probability score is identified as the speech input.

More fundamentally, Brown uses grammars in performing speech recognition based on a Hidden Markov Model (HMM). (See, e.g., Col. 4, lines 15-42.) The intent of Brown is to avoid loading into memory the whole graph that corresponds to a sentence. Instead, as more speech is processed, more of the graph is loaded into memory. As progress is made through the HMM, the graph is unloaded.

Wilson is directed to a system and method for modeless large-vocabulary speech recognition. Speech recognition with Wilson entails arranging acoustic model states to form acoustic models, each acoustic model being composed of a sequence of segment models and each segment model being composed of a sequence of the acoustic model states. (Col. 1, lines 65 - 67; Abstract.) Wilson compares each vector of a sequence of speech-derived input vectors to a set of model states in order to produce a match score for each model state in the set. The score reflects a likelihood that a particular state is represented by a particular vector. (Col. 2, lines 1 - 5; Abstract.) Wilson then uses a plurality of recognition modules operating in parallel with associated recognition grammars to determine at least one recognition result in each recognition module based on the match scores. (Col. 2, lines 5 - 9; Abstract.) At least one recognition result is then

selected by Wilson based on an arbitration algorithm and a score ordered queue of the recognition results together with the associated recognition modules.

Fundamentally, Wilson's speech recognition entails running several models in parallel and arbitrating among them to select a grammar to process a sequence of words. The algorithm employed by Wilson is a runtime algorithm that is used to select the grammar that matches a sequence of acoustic observations in performing speech recognition.

Applicants respectfully assert that Brown and Wilson, individually as well as combined, fail to teach or suggest each feature of Applicants' invention. For example, neither reference teaches examining each possible substring using an inventory of grammar-related queries corresponding to a context-free grammar, wherein the queries are ordered during training of an NLU system in order to form a decision tree, and wherein the ordering of the queries is a statistical ordering based on a minimization of conditional entropy or maximization of a likelihood that a resulting model predicts data used to train the NLU system.

As recited in amended independent Claims 1, 16, 20, 43, and 48, the ordered, grammar-related queries are included within a statistical parser for use in an NLU model. The inclusion of the ordered, grammar-related queries provides a mechanism by which the statistical parser is guided, based either on decision trees or the principle of maximum entropy. One benefit of the arrangement is that the accuracy of the NLU system is raised while the amount of training data needed to train the NLU system is reduced.

No such queries are taught or suggested by Brown or Wilson. Brown, as already noted, is directed to a method and system for paging-in an HMM as needed, and removing it when it is no longer useful. Brown makes no mention of including grammars into the training or runtime of a statistical parser. Brown provides for post-processing after speech recognition is complete in order to reconstruct a path through the recursive

transition of the HMM that matches the speech recognition results. But this is not related to Applicants' invention.

More particularly, as expressly noted at page 3 of the Office Action, Brown does not teach the use of an inventory of queries. The lack of such a feature, moreover is not provided by Wilson. Although Wilson speaks to "scoring" and "context-free grammars," Wilson's scoring is unrelated to the queries recited in amended independent Claims 1, 16, 20, 43, and 48. Wilson's scoring is a scoring of speech input using context free grammars in conjunction with acoustic model processing. (Col 6, lines 13 - 19.) This, however, is not related to the use ordered queries to examine each possible substring and corresponding parse tree derived from a received text input, as recited in amended independent Claims 1, 20, 43, and 48. Nor is it related to a system having an inventory of such ordered queries, each corresponding to at least one CFG, as recited in amended independent Claim 16.

Wilson's scoring, even though involving context-free grammars, does not involve scoring each possible substring and corresponding parse tree. Indeed, Wilson does not remotely suggest the use of queries generally, or ordered queries specifically, let alone their use in the context of examining each possible substring and corresponding parse tree derived from received text input. Nothing in Wilson suggests examining each possible substring using ordered queries, as recited in amended independent Claims 1, 20, 43, and 48.

Applicants' examination of each possible substring and corresponding parse tree using ordered queries provides a guide to the statistical parser as it statistically constructs a parse tree, the construction being based on statistical determinations made at discrete stages during construction. Wilson's scoring does not provide such capabilities. Applicants' examination with ordered queries improves the accuracy of the NLU model while reducing the amount of training data needed to train the model. Wilson's scoring of

speech input merely enables "the processing results of the acoustic model" to be shared so as to "reduce the computational load." (Col. 6, lines 21-24.)

Applicants' invention can allow all grammars to be used in identifying all possible grammar matches relating to the received text input, which, in turn, can be used as ordered queries or, as discussed below, weighted features within the statistical parser. The ordering of the queries, moreover, can reflect the nature of the particular statistical parser in which the queries are included. None of this can be achieved with either Brown or Wilson.

Brown and Wilson, both individually and in combination, similarly fail to teach or suggest the use of weighted features, as recited in amended independent Claims 18, 24, and 39. Brown's use of probability scores, as already noted, are used to reconstruct a path through the recursive transition of the HMM that matches speech recognition results. (See, Col. 4, lines 27-42.) But, again, this is not related to Applicants' invention. Neither Brown nor Wilson teach or suggest the inclusion of weighted, grammar-related features in a statistical parser. Wilson's scoring of speech input and Brown's assigning probability scores to reconstruct paths do not remotely suggest weighted, grammar-relates scores as recited in amended independent Claims 18, 24, and 39.

Neither Wilson's score nor Brown's, more particularly, suggest weighted grammar-related features that each correspond to at least one CFG, as recited in amended independent Claim 18. Nor do either of the references, individually or jointly, suggest examining each said possible substring and corresponding parse tree using one or more weighted grammar-related features, as recited in amended independent Claims 24 and 39.

As with the ordered queries described above, the inclusion of the weighted features in a statistical parser provides a mechanism by which the statistical parser is guided. The weighted features can be used by the statistical parser as a guide as the parser statistically constructs a parse tree, the construction being based on statistical

determinations made at discrete stages during construction. Again, the benefit of this is that the accuracy of the NLU system is raised while the amount of training data needed to train the NLU system is reduced. Neither Wilson's scoring of speech input nor Brown's scoring in the context of path reconstruction provide such capabilities.

Applicants respectfully submit that whereas Brown and Wilson fail to teach or suggest each feature recited in amended independent Claims 1, 16, 18, 20, 24, 39, 43, and 48, the claims are not rendered obvious by the prior art. Additionally, Applicants respectfully submit that whereas each of the remaining claims depends from one of the amended independent claims while reciting additional features, the remaining claims are likewise not rendered obvious by the prior art.

CONCLUSION

Applicants believe that this application is now in full condition for allowance, which action is respectfully requested. Applicants request that the Examiner call the undersigned if clarification is needed on any matter within this Amendment, or if the Examiner believes a telephone interview would expedite the prosecution of the subject application to completion.

Respectfully submitted,

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